ROOT CUTTINGS FOR ROADSIDE SLOPE STABILIZATION

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PURDUE UNIVERSITY AND

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Interim Report

ROOT CUTTINGS FOR ROADSIDE SLOPE STABILIZATION

TO: J. F. McLaughlin, Director
Joint Highway Research Project

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FROM: H. L. Michael, Associate Director
Joint Highway Research Project

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The attached Interim Report is another on Part II, "Selection, Establishment and Maintenance of Woody Ornamentals for Highway Plantings", of the HPR Part II research study "Research in Roadside Development and Maintenance". This Report is titled "Root Cuttings for Roadside Slope Stabilization" and is presented as partial fulfillment of the objectives of this study.

This Report presents the results of three experiments in the use of root cuttings on highway slopes. The findings indicate that root cuttings are a feasible way to establish woody plants on highway slopes. Two species were found to produce adequate cover.

The Report is presented to the Board for acceptance and after acceptance will be forwarded to the ISHC and the FHWA for similar acceptance and review and comment.

Respectfully submitted,

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Introduction and Review of Literature

The problem of establishing highway plantings has been approached in many different ways. Whatever method of planting is used, there must be rapid establishment over a wide range of disturbed and impoverished soils. Plantings must also be relatively inexpensive to establish and must require a minimum of maintenance. In many areas woody ornamental plants are more efficient than grass in meeting these needs. Furthermore, many situations where woody ornamental plants are desirable require mass plantings with a rapid, complete cover the primary objective. Currently, the main use of woody ornamental plants is for group plantings at highway interchanges and along median areas. These areas are established with plants of several season's growth and by bare rooted or balled and burlapped plants depending upon the species and size. In areas such as slopes where mass plantings are needed, other means of establishment must be used. Establishment by direct seeding and young seedlings have been tried, but almost no attempts have been made at mass propagation with root cuttings.

The root cutting method of propagation, although the least frequently used method of vegetative propagation, is probably the least expensive and the most simple means of mass propagation (5). Root cuttings may also be planted by mechanical means. Propagation by root cuttings is by far the best method for increasing certain

plants useful along highways which do not bear reliable seed and which can not be established readily by other means of propagation (9). Timing of propagation by root cuttings is very critical. Hartmam and Kester state that the best results are likely to be obtained on cuttings from young two- to three-year old stock plants in late winter or early spring when roots are supplied with stored foods but before growth starts. They further say that root cuttings should not be taken in the spring when the parent plant is rapidly making new shoot growth (5). Stoutmeyer states that root cuttings taken in the fall are not likely to overwinter successfully (9).

Size of root cuttings used in propagation also appears critical. Root cuttings of trees and shrubs should be from two to six inches long (5).

Hartmam and Kester (5) list about forty species of woody plants successfully propagated by root cuttings. Among them are many plants of possible use along highways, such as: *Comptonia peregrina* (sweet fern), *Rhus glabra* (smooth sumac), *Robina hispida* (moss locust), and *Sassafras albidium* (sassafras).

With this information under consideration, experiments were designed with the following objectives:

(1) to study the feasibility of stabilizing roadside slopes with woody ornamental plants propagated from root cuttings.

(2) to evaluate the response of species of plants commonly propagated by root cuttings under highway conditions.

(3) to determine rates of planting of root cuttings necessary for sufficient slope cover.

(4) to determine the best planting dates for propagation by root cuttings.

(5) to study the use of growth regulators for induction of roots on root cuttings.

Experiment 1: Establishing Highway Slopes With Woody Plants Planted as Root Cuttings in Spring

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes with woody plant materials propagated from root cuttings was established on May 13, 1968, along Interstate 74. The planting site was a slope with a western exposure and a three-year cover of grasses. After tilling to a three-inch depth, two- to four-inch root cuttings of *Comptonia peregrina* (sweet fern), *Rhus glabra* (smooth sumac), and *Robinia hispida* (moss locust) were spread by hand and then covered with a three-inch bark mulch. Each species was planted in plots of 100 square feet, and randomly replicated three times on the slope. Root cuttings were planted at the following densities: *Comptonia peregrina* at four per square foot, *Rhus glabra* at two per square foot, and *Robinia hispida* at one per square foot. No fertilization or watering program was maintained, although rainfall supplied adequate moisture for establishment of the root cuttings. The average weekly rainfall was: 1.98 inches in May, 0.82 inches in June, 0.88 inches in July, 1.38 inches in August, and 0.49 inches in September.

Results and Discussion

Initial observations made June 14, 1968, showed shoot development from root cuttings of *Rhus glabra* and *Robinia hispida*, while shoot development was not observed from root cuttings of *Comptonia peregrina* until July 3, 1968. The number of root cuttings of all species giving shoot development increased throughout the first summer (Table 1). Plant counts made September 9, 1968, showed that the percentage of root cuttings established was considerably larger for *Rhus glabra* than for the other species (Table 2). Even though *Rhus glabra* showed the highest percentage of shoot development from root cuttings the first summer, root cuttings of *Robinia hispida* showed better survival counts after the first winter (Table 3). Survival of root cuttings of *Comptonia peregrina* was extremely poor during the first winter. After the first winter the percentage of root cuttings of all species surviving decreased only slightly.

Plant heights were also taken periodically thoroughout this study (Table 4). *Rhus glabra* consistently gave the most rapid growth (Fig. 1). For the final plant height May 14, 1971, only maximum heights were taken. *Rhus glabra* was found to have a maximum height of seven feet, (Fig. 2), *Robinia hispida* a maximum height of two feet, and *Comptonia peregrina* only one foot.

The percentage of root cuttings of *Robinia hispida* and *Comptonia peregrina* showing shoot development is small, but for *Robinia hispida* the total number of plants is adequate to give sufficient tree cover on

slopes. Root cuttings of Comptonia peregrina would be unsatisfactory for roadside slope stabilization, with only marginal cover being obtained. Rhus glabra would provide excellent and rapid tree cover on highway slopes when planted as root cuttings (Fig. 2).

Table 1. Total Number of Shoots Developing from Root Cuttings of *Rhus glabra*, *Robinia hispida* and *Comptonia peregrina* planted on May 13, 1968.

Plant	Total Number of Shoots			
	Date			
	July 12, 1968	September 9, 1969	April 22, 1969	May 14, 1971
Rhus glabra	318	464	277	205
Robinia hispida	41	44	36	34
Comptonia peregrina	36	39	9	8

Table 2. Percentage of Root Cuttings of *Rhus glabra*, *Robinia hispida* and *Comptonia peregrina* Showing Shoot Development

Plant	Percent Showing Shoot Development			
	Date			
	July 12, 1968	September 9, 1968	April 22, 1969	May 14, 1971
Rhus glabra	53.0	77.3	46.2	34.2
Robinia hispida	13.7	14.7	12.0	11.3
Comptonia peregrina	3.0	3.3	0.8	0.7

Table 3. Percentage of Root Cuttings Producing Shoot Development by September 9, 1968, Surviving in April 1969, and May 1971.

Plant	Percent Survival Date April 22, 1969	 May 14, 1969
Rhus glabra	59.6	44.0
Robinia hispida	81.8	76.9
Comptonia peregrina	23.1	20.0

Table 4. Height of Robinia hispida and Comptonia peregrina September 9, 1968.*

Height (inches)	Percentage of Plants at Measured Height: Robinia hispida	Percentage of Plants at Measured Height: Comptonia peregrina
1	10.3	2.0
1-3	43.6	13.6
4-5	28.2	47.7
6-7	10.3	29.5
7	7.7	6.8

* Because of the large number of plants of Rhus glabra only a maximum height was taken. Maximum was ten inches.

Fig. 1. Root and Shoot Growth from a Root Cutting of <u>Rhus glabra</u> after Three Months.

Fig. 2. A Three-year Cover of Rhus glabra Planted as Root Cuttings.

Experiment 2: Establishing Highway Slopes with Woody Plants Planted as Root Cuttings in Fall

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes with root cuttings planted in the fall was established in the fall of 1968 along Indiana State Highway 526 on a slope with a western exposure. The slope was cleared of natural vegetation and tilled to a three-inch depth before root cuttings were planted. Plantings were made September 18, 1968; October 1, 1968; and October 15, 1968. Plots were thirty square feet for each species and were replicated three times at each planting date. Two- to four-inch root cuttings of *Robinia pseudoacacia* (black locust), *Comptonia peregrina* (sweet fern), *Sassafras albidium* (sassafras), *Rhus typha* (staghorn sumac), and *Rhus glabra* (smooth sumac) were spread by hand at a density of one root cutting per square foot and then covered with a three-inch bark mulch. Plantings made October 1, and October 15, 1968, were watered immediately after planting.

Results and Discussion

Observations made the following spring showed no establishment of root cuttings planted the previous fall. Failure of the root

cuttings to overwinter cannot be attributed to any specific factor, but is undoubtably a combination of both environmental and physiological factors. Fall planting of root cuttings is apparently not a feasible way to stabilize roadside slopes as root cuttings will not remain viable throughout winter.

Experiment 3: Promotion of Rooting in Root Cutting Propagation

Introduction and Review of Literature

From observations on unpublished propagation research, it has been noted that certain woody plant species when propagated from root cuttings will develop shoot growth of a few inches without developing a root system. The shoot growth eventually dies without the root system. Thus the plant from that cutting is lost.

Auxin, an auxin synergist, ethylene, and an antimetabolite were used as possibilities of promoting root initiation and development on root cuttings of Rhus glabra, Comptonia peregrina, and Sassafras albidum. These growth controlling compounds were investigated because of the variety of mechanisms which are believed to be controlled either by the substance alone or in combination with each other.

Auxin at high concentration has been reported to be a strong inhibitor of root development (6,15) except in a few special cases (4,6). Fretz and Davis (4) found adventitious root formation in species of Ilex and Juniper at 2500 and 5000 ppm concentrations of auxin applied as a dip. At low concentrations, auxin has been found to stimulate root development in special cases (15).

Went (11) originally suggested that factors other than auxin were needed to promote root formation. Little about these other factors has been made completely clear since then, but many compounds

and theories have been explored. One category of compounds explored has been phenolic acid used as synergist with auxin. Leopold (6) and Zenk and Muller (14) have classified the phenolic acids into groups which affect decarboxylation of auxin and those which inhibit growth. Even though slaicylic acid has been listed as a growth inhibitor with no synergistic effect (6), Basu, Bose, Roy and Mukhopudhyay (1) found it promoted rooting in combination with auxins.

Ethylene is also classified as a growth substance and has the following effects on root systems: (1) inhibits the elongation of growth in roots, (2) induces the formation of root-hairs (10). In addition, workers have found root development to have been affected directly and indirectly by auxin as it affects ethylene and vice versa (2,10,12). Ethrel, because it breaks down evolving ethylene (13), was included so as to promote root initiation, if not root development.

Antimetabolites (B-Nine and others) were first found to inhibit or be ineffective in root formation and development of herbaceous cuttings (3). Recently, however, Reed and Hoysler (7,8) found B-Nine to promote rooting on stem cuttings of three floral crops while other antimetabolites had no effect.

The purpose of the following research was to determine which of these compounds or combinations would induce root development in woody species.

Materials and Methods

The plant material was selected for two reasons. Comptonia peregrina (sweet fern) and Sassafras albidum (sassafras) were used because of their ability to produce shoot growth without a root system. Rhus glabra (smooth sumac) was selected as a control because it had not shown this characteristic and it had been very successful in its ratio of new plants produced per cuttings planted in earlier studies.

Cuttings from each species were identified to be root and not rhizome by microscopic technique.

Comptonia peregrina cuttings came from 100 plants collected natively within the state of Connecticut. Rhus glabra cuttings were taken from three nursery-grown plants and Sassafras albidum cuttings are from one young native tree. Both of the later plants were obtained in the Lafayette, Indiana area.

All plants were dug between November 15-19, 1971, and planted between November 22-25. While plants were not in transit, all roots were kept at 38^{o} F.

Cuttings were made between 7 and 8 cm in length. The diameter varied between 3 and 10 mm with Comptonia and Sassafras varing between the extremes. The Rhus cuttings were more uniform. Treated cuttings were placed in six-inch deep flats containing a peat: perlite mixture (1:1 v/v). The potting mixture was kept moist by daily handwatering.

Treatments consisted of solutions of IBA (3-indolebutryic acid),

B-Nine (succinic acid-2,2-dimethylhydrazide), and Ethrel (2-chloroethylphosphonic acid) at 1 or 10 ppm with a 25-hour soak or at 1000, 2500, or 5000 ppm with a 15-second dip. Additional treatments included salicylic acid (10 mg/L) with a 25-hour soak followed by a 15-second dip with IBA at 1000 or 2500 ppm. Foliar applications of Ethrel at 50 or 100 ppm or B-Nine at 100 ppm were made after 2 to 4 leaves developed on new shoot growth. These cuttings were initially treated with a 15-second dip in deionized water prior to planting and growth development. Controls consisted of a soak for 25 hours and a dip for 15 seconds in deionized water.

All cuttings were completely submerged during treatment and then allowed to dry for 15 to 30 minutes proper to planting. Each treatment contained five cuttings with each of these replicated five times.

Results and Discussion

Only fragmented results occured with root cuttings from Rhus glabra and Sassafras albidium which were treated with growth promoting substances (Table 5 and Table 6). Since no favorable results occurred with these two plants, it is felt additional work in the areas of age of cutting, season it was obtained, and with diameter and length of cutting is needed.

Comptonia peregrina responded extremely well to being propagated by root cuttings during November in a greenhouse. There were no

differences in the number of cuttings forming shoots or forming roots between treatments and controls. A difference in the number of roots produced did occur (Table 7). IBA at 2500 and 5000 ppm did increase the number of roots as did the treatment of salicylic acid plus IBA at 2500 ppm. Not enough evidence is present to differentiate between a synergistic effect of salicylic acid and the response due solely to IBA at 2500 ppm.

At least _C. peregrina_ could benefit from a treatment with growth promoting substances. Other plants to be established by the root cutting procedure may also benefit, but further work is need to determine their success on the highway planting site.

Table 5. Response of <u>Rhus glabra</u> root cuttings to root promoting substances.

Treatment	No. of Shoots Formed	% of Cuttings Forming Shoots	No. of Roots Formed	% of Cuttings Rooted
IBA 1 ppm	15	28	18	24
IBA 10 ppm	15	36	9	20
IBA 1000 ppm	25	52	1	4
IBA 2500 ppm	43	76	10	24
IBA 5000 ppm	6	20	14	16
B-Nine 1 ppm	13	32	3	8
B-Nine 10 ppm	16	44	16	28
B-Nine 1000 ppm	8	28	17	24
B-Nine 2500 ppm	39	64	30	36
B-Nine 5000 ppm	19	48	5	12
Ethrel 1 ppm	24	68	21	36
Ethrel 10 ppm	5	16	3	4
Ethrel 1000 ppm	8	32	10	8
Ethrel 2500 ppm	29	60	12	20
Ethrel 5000 ppm	2	8	6	8
Salicylic acid	14	36	8	20
Sali acid-IBA 1000 ppm	40	64	21	36
Sali acid-IBA 2500 ppm	25	48	4	12
H_2O_{15}--B-Nine 100 ppm	20	64	41	40
H_2O_{15}--Ethrel 50 ppm	30	52	19	16
H_2O_{15}--Ethrel 100 ppm	2	8	1	4
H_2O--15 sec. dip	26	60	16	28
H_2O--24 hr. soak	14	36	21	32

Table 6. Response of <u>Sassafras albidium</u> root cuttings to root promoting substances.

Treatment	No. of Shoots Formed	% of Cuttings Forming Shoots	No. of Roots Formed	% of Cuttings Rooted
IBA 1 ppm	0	0	0	0
IBA 10 ppm	1	4	3	4
IBA 1000 ppm	0	0	0	0
IBA 2500 ppm	3	12	2	8
IBA 5000 ppm	3	12	10	16
B-Nine 1 ppm	0	0	0	0
B-Nine 10 ppm	1	4	0	0
B-Nine 1000 ppm	0	0	6	12
B-Nine 2500 ppm	2	8	2	8
B-Nine 5000 ppm	3	8	4	16
Ethrel 1 ppm	4	8	4	8
Ethrel 10 ppm	0	0	1	4
Ethrel 1000 ppm	0	0	0	0
Ethrel 2500 ppm	0	0	0	0
Ethrel 5000 ppm	1	4	1	4
Salicylic acid	0	0	0	0
Sali acid--IBA 1000 ppm	0	0	0	0
Sali acid--IBA 2500 ppm	1	4	8	8
H_2O_{15}--B-Nine 100 ppm	3	12	8	12
H_2O_{15}--Ethrel 50 ppm	1	4	12	24
H_2O_{15}--Ethrel 100 ppm	2	8	10	20
H_2O--15 sec. dip	2	8	7	4
H_2O 24 hr. soak	1	4	1	4

Table 7. Response of <u>Comptonia peregrina</u> root cuttings to root promoting substances.

Treatments	No. of Shoots Formed	% of Cuttings Forming Shoots	No. of Roots Formed	% of Cuttings Rooted
IBA 1 ppm	28	72	131	84
IBA 10 ppm	38	96	148	92
IBA 1000 ppm	32	84	129	88
IBA 2500 ppm	31	80	156	76
IBA 5000 ppm	35	92	266	92
B-Nine 1 ppm	40	80	144	96
B-Nine 10 ppm	44	80	76	80
B-Nine 1000 ppm	36	84	143	100
B-Nine 2500 ppm	33	76	83	60
B-Nine 5000 ppm	23	76	101	88
Ethrel 1 ppm	37	84	119	84
Ethrel 10 ppm	30	64	91	76
Ethrel 1000 ppm	34	80	162	72
Ethrel 2500 ppm	30	60	99	84
Ethrel 5000 ppm	27	52	81	72
Salicylic acid	46	100	99	92
Sali acid--IBA 1000 ppm	29	80	125	76
Sali acid--IBA 2500 ppm	31	84	217	100
H_2O_{15}--B-Nine 100 ppm	10	45	52	75
H_2O_{15}--Ethrel 50 ppm	39	80	68	72
H_2O_{15}--Ethrel 100 ppm	24	70	76	75
H_2O--15 sec. dip	25	68	41	56
H_2O--24 hr. soak	34	80	85	84

Conclusions and Practical Applications

1. Root cuttings of _Rhus glabra_ planted a two per square foot is sufficient to give complete and rapid tree cover on roadside slopes. Overwintering of root cuttings of _Rhus_ established the first year is good.
2. Root cuttings of _Robinia hispida_ planted at one per square foot is enough to produce adequate tree cover, but is slower growing than _Rhus glabra_. Overwintering of root cuttings of _Robinia_ established the first year is excellent.
3. Establishment of _Comptonia peregrina_ by root cuttings four per square foot along highway roadside is not sufficient for adequate stabilization and cover.
4. Fall planting of root cuttings is not recommended. None of the root cuttings studied survived the winter and produced growth the following spring.
5. Treatment of root cuttings of _Comptonia peregrina_ with growth promoting substances increases the number of roots formed.

These experiments have shown that root cuttings are definitely a feasible way to establish highway slopes with woody plants. Additional work is needed to evaluate other species of plants, to determine the best type of root cutting, and to determine the success of root promoting substances on stimulating root growth in highway planting sites.

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